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Emergent Imaginaries and Fragmented Policy Frameworks in the Canadian Bio-Economy

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Abstract: Climate change means that countries like Canada need to find suitable transition pathways to overcome fossil-fuel dependence; one such pathway is the so-called 'bio-economy'. The bio-economy is a term used to define an economic system in which biological resources (e.g., plants) form the basis of production and production processes. For example, it would involve the replacement of petroleum energy, inputs, chemicals, and products with bioenergy, biological inputs, bio-chemicals, and bio-products. A number of countries and jurisdictions have established policy strategies in order to promote and support the development of a bio-economy, exemplified by the European Union where the bio-economy represents a key pillar in its broader Horizon 2020 strategy. Other countries, like Canada, do not yet have an over-arching bio-economy strategy, but have a series of diverse, and often competing, policy visions and frameworks. It is useful to analyse countries like Canada in order to understand how these policy visions and policy frameworks are co-constituted, and what this might mean for the development of an over-arching bio-economy strategy. This raises a number of questions: How is the bio-economy imagined by different social actors? How are these imaginaries and policy frameworks co-produced?

Keywords: bio-economy; bio-based economy; biofuels; policy imaginaries; policy frameworks; Canada

1. Introduction

> "DASANI® is taking steps to reduce its impact on the planet with a major innovation in bottle design. PlantBottle® packaging is made from up to 30% plant-based material that replaces some of the non-renewable petroleum or fossil-based resources used in conventional PET plastic. Still designed to be 100% recyclable, it helps save our world's precious resources" [1].

According to the multinational corporation Coca-Cola, it introduced its PlantBottle® in 2009 as part of a policy to reduce the use of fossil fuel-based plastics in their products. As should be obvious from its trademarking of the term "PlantBottle" Coca-Cola has marketed the use of these bio-based materials using terms we are all familiar and comfortable with (e.g., plants, plant-based, etc.). This "PlantBottle" represents a clear example of the so-called *bio-economy*, a concept that emerged in policy circles in the mid-2000s with the creation of new policy agendas by the Organisation for Economic Co-operation and Development and European Commission [2–4]. Since then, the bio-economy has become an increasingly important policy agenda around the world; for example, countries like the USA, Germany, UK, and Japan have all developed dedicated bio-economy policy strategies [5,6].

The bio-economy is generally used in these policy circles to refer to a range of industrial sectors producing biological products or resources, from healthcare, to forestry, to agriculture. This has led to the conceptual conflation of the terms "bio-economy" and "bio-based economy" [7]. Increasingly, it is used to refer to a possible societal transition from a fossil fuel-based economy to a biological-based economy [8]. More specifically, this transition is premised on the substitution of fossil fuel-based

energy, plastics, material, and chemicals with bio-based ones. As such, the bio-economy is often seen as a win-win solution to a series of overlapping societal challenges, from climate change, to energy security, to rural economic development [9,10]. Part of the (policy) attraction of the bio-economy seems to be its compatibility with existing social institutions and infrastructures, meaning that it would not require significant changes to social life; for example, (blended) ethanol and biodiesel can slot into existing petroleum value chains with little need for change.

In this paper I theorize the bio-economy as a policy framework involving a vision, or imaginary, of the future and a particular set of proposed policies and institutional changes for achieving that vision [11–15]. Initially, the bio-economy concept was used to refer to the "the recent surge in the scientific knowledge and technical competences" [4] (p. 3), or the idea that "knowledge has become an extremely valuable economic resource" [2] (p. 1). The particularities of these new (bio-)knowledges, however, means that policy-makers face significant difficulties in managing the impacts and outcomes of scientific research and innovation. For example, the OECD argued that:

> "The challenge facing policy makers—whether in government, in private industry or elsewhere—is how to make choices that allow the opportunities offered through biotechnology, genetics, genomics and the biosciences more generally to be delivered. This can be problematic, since decisions taken today can influence whether unforeseen or unconfirmed future opportunities might be realizable. A degree of foresight or vision is therefore necessary so that, to the extent possible, short-term decisions can be taken without negative impacts on longer term opportunities" [4] (p. 5).

In this sense, and as Hilgartner notes, the OECD's bio-economy concept represents an "anticipatory machine" or a "future-making project" [16], rather than a simple description or outline of a new sector, new product market, or new resource base. According to several other scholars [11–15], the bio-economy concept has been used discursively to frame *current* policy frameworks and institutions as potentially or actually problematic to the realization of the *future* opportunities offered by the biological sciences, necessitating policy and institutional change. Much of this existing research, however, focuses explicitly on the European Union.

My aim in this paper is to examine Canada's emerging bio-economy policy visions and their implications for Canadian bio-economy policy frameworks. I do so in order to answer a series of related questions: What kind of policy visions are evident in the Canadian context? How do these visions define the bio-economy? How do these definitions inform policy frameworks? What are the implications of these visions and frameworks for institutional change? It is my conclusion that, at present, Canadian bio-economy policy frameworks are fragmented as a result of the emergent and contested nature of Canadian bio-economy policy visions, meaning that future policy and institutional changes deemed necessary to promote the bio-economy are currently stymied. The policy implications of this conclusion are that Canada needs a single, coherent bio-economy vision that a majority of policy stakeholders can buy into before it can develop a policy strategy needed to promote and support the bio-economy.

I start the paper by discussing my conceptual approach linking policy visions with policy frameworks, which thereby drives policy and institutional change. I then provide a brief outline of the methodological approach I took in the research before discussing the empirical findings. In the empirical analysis I focus on the emergence of diverse, often competing, visions of the bio-economy in the Canadian context and the fragmentation of policy frameworks that result from this diversity. I then conclude the paper.

2. Imagined Futures: Policy Visions and Policy Frameworks

As mentioned already, an increasing number of national governments have, or are developing, strategies to support and promote the bio-economy [2–6,17–19]. For example, the European Union's (EU) Horizon 2020 strategy—a replacement for the Lisbon Agenda [20]—includes the bio-economy as a way

to achieve "a more innovative, resource efficient and competitive society" [17] (p. 2). Several scholars have analysed some of these policy strategies, including Staffas et al. [21], who reviewed various national strategies, and de Besi and McCormick [22], who reviewed a number of national, regional, and industry strategies.

These policy strategies are constituted by both visions of the future—often involving competing social, political, economic, and scientific priorities—and frameworks for achieving those visions, creating a performative driver towards the *imagined* future [16]. As such, policy strategies enrol support, redirect resources, shape regulations, and create markets in a diverse range of policy areas, including research, innovation, industry, energy, transport, and agriculture. At present, dominant policy strategies tend to imagine the bio-economy as a sustainable system in which biological materials (e.g., biomass) can replace, relatively easily, fossil fuels as the underlying resource base for our societies and economies [9,23]. As such, the bio-economy is framed as an important and cost-effective socio-technical transition pathway leading us to a sustainable future. Key elements in this transition pathway are the development of new forms of energy (e.g., liquid biofuels), new forms of intermediate inputs (e.g., biochemicals), and new forms of products (e.g., bioplastics) [10,24,25].

Theoretically, I follow the likes of Birch et al. [12,13], Levidow et al. [14,15] and Birch [11] in conceptualizing the bio-economy as a particular policy vision and framework (also, [16]). It represents a techno-economic imaginary of the future that is co-produced with certain policies, institutions, and infrastructures that are framed as desirable and possible, while others are framed as undesirable or problematic. It is important, from this perspective, to examine and analyse how the bio-economy is constituted by imaginaries and policy frameworks, reflecting an overall policy strategy designed to (re)configure a particular techno-economic regime or system.

Starting with *imaginaries*, these have a long conceptual history stretching back to Cornelius Castoriadis, Benedict Anderson, Charles Taylor, and George Marcus. More recently, Sheila Jasanoff [26] has analysed the co-production of socio-technical imaginaries and national science policy. Others, like Bob Jessop [27], have analysed economic imaginaries (e.g., 'knowledge-based economy') as discourses that underpin particular regimes of accumulation (e.g., post-Fordism). Generally, this research highlights the role of discourses, narratives, and visions in the (re)configuration of socio-economic phenomena, like scientific research or economic activity (also, [28]. For example, imaginaries provide a conceptual tool to analyse how social actors understand policies, how policy frameworks emerge, and the social actors involved, or excluded from, the development of future visions of society.

Imaginaries and policy frameworks are co-constituted, enrolling a range of stakeholders in the pursuit of particular policy strategies [25]. Policy frameworks can be conceptualized as the policy priorities, analysis, funding, schemes, initiatives and directives, and implementation modes that cut across policy-making, ensuring that policies are compatible and complementary [12]. Analysing policy frameworks helps to explain: (1) how policy imaginaries are aligned with a particular, and often prevailing, configuration of socio-economic institutions and infrastructures [24]; and (2) how this prevailing configuration might be opened up and alternatives adopted [10,12,15]. On the one hand, scholars have noted how dominant bio-economy visions and policy frameworks tend to be so broadly conceived that they represent "something for everyone"—e.g., sustainability, energy security, rural development, etc. [9]. On the other hand, a number of scholars have been critical of how dominant policy visions of the bio-economy are centred on finding techno-scientific solutions to societal problems, rather than rethinking the social, political, economic, and ecological systems that bio-economy policies are supposed to transform [29].

In light of this theoretical discussion, I have two analytical objectives in the rest of this paper. First, while there is now a growing literature discussing the bio-economy [21,30–32], much of it only focuses on certain jurisdictions or jurisdictional examples—especially the European Union (EU) and its member states—and certain policy actors—especially government actors. There is, therefore, a need to examine a broader array of bio-economy strategies and their constitutive elements and actors in depth.

It is my intention in this paper to look beyond the EU by examining the Canadian bio-economy and the government, industry, and civil society stakeholders involved in order to understand what policy imaginaries and frameworks exist in Canada and how they have emerged, or are emerging. This will provide a useful comparative perspective to existing work [11–15].

Second, in the extant literature on imaginaries (e.g., [26,27]), the examples of policy visions, narratives, and discourses (i.e., imaginaries) analysed are generally dominant or stabilized imaginaries; while they may have once been emergent, the analysis tends towards explaining stable and dominant imaginaries, rather than analyzing the diversity and range of potential or emergent visions before a dominant imaginary stabilizes. An example is Jasanoff and Kim's [33] work on nuclear imaginaries in South Korea and the USA; they describe the dominant imaginaries of each nation-state, rather than the potential imaginaries that could have stabilized. Obviously, this analytical focus results from the practicalities of the research process; for example, Jasanoff and Kim had to take a retrospective approach in their analysis, since they were examining historical events. In this paper, in contrast, I am analyzing emergent imaginaries, each of which could, potentially, become dominant or stabilized in a particular policy framework; it is likely that a single (Canadian) imaginary will emerge from a range of different, diverse, and even competing, visions, but it is unclear what this imaginary will entail or when it will stabilize at present.

3. Methodological Note

The empirical material analyzed in this paper comes from a broader project looking at the development of advanced biofuels in Canada. The project had three main objectives, one of which was to examine the policy discourse on the bio-economy in Canada. This part of the project involved in-depth interviews with 19 'policy' actors from across government, industry, and civil society (see Table 1). The interviews were completed in 2014 and focused on several issues relating to the existence, development, and implications of bio-economy policy strategies in Canada. In this paper I report on the definitions and discussions of the bio-economy and the policy supports in place to promote the bio-economy in Canada. I use the interview material here to explore social processes—such as imaginaries and policy frameworks—rather than the values and meanings ascribed to social phenomena by the informants themselves. I supplement this analysis by selectively drawing on a range of secondary material (e.g., policy documents) produced by government, industry, and civil society.

Table 1. Research informants.

Policy Actor	Number	Examples
Government	5	Federal ministries and agencies; Provincial ministries and agencies
Business	9	Biofuel companies; Trade associations (biotech, biofuels, feedstock suppliers); Consultancies
Civil Society	5	Academia; Non-profit support initiatives

4. Emergent Imaginaries in the Canadian Bio-Economy

Imaginaries are often geographically-specific, in that different countries are characterized by different visions of the future. For example, when it comes to the bio-economy in Canada, future visions have been driven, generally speaking, by a radical shift in the Canadian economy away from its traditional (self-)conception of Canada as "hewers of wood" to one based on scientific research and high-tech development (e.g., [34]). It is not my intention to analyse these geographical imaginaries in this paper, however [25,35]. Instead, my aim in this section is to analyze the different—sometimes overlapping, and sometimes competing—definitions of the bio-economy in the Canadian policy context. I outline four definitions of the bio-economy used by various policy actors and analyze the origins of these definitions and their relationships to particular policy visions. The four definitions are: (1) *product-based*; (2) *substitution*; (3) *renewable-versus-sustainable*; and (4) *societal transitions*.

4.1. Competing Definitions of the Bio-Economy 1: Bio-Based Products

One of the dominant definitions used by policy actors is the idea that the bio-economy is the development and manufacture of new bio-based products and energy; examples range from the low-tech end with wood-based, disposable cutlery, through bulk energy resources, like ethanol or cellulosic biofuels, to high-end chemicals, like succinic acid. The key defining characteristic of the bio-economy is that these products, energy, etc., must be manufactured using biological inputs (e.g., agricultural waste, timber, etc.). For examples of this definition see Table 2 below.

Table 2. The bio-economy as a product definition (part 1).

Informant	Definition
Consultancy (#93)	"It would be the manufacturing use of products that are made from biological organisms. So things that are grown, can live, and be harvested and sustainably used again through the life-cycle of an organism."
Trade Association (#99)	"From our vantage point we view the bio-economy as any product or thing, if you will, that can be produced from crops that isn't traditionally food."
Consultancy (#100)	"Making stuff from carbohydrates... So basically, I'm saying that manufacturing products that come in whole or in part from biomass."
Federal Agency (#106)	"For me the bio-economy is the development of technologies and products that are derived from things that use as an input naturally occurring materials... but something that comes from an organic nature."
Provincial Ministry (#110)	"I think bio-economy composes of anything that includes the use of either whole of significant part of any biological renewable materials or any organic materials from plants and animals which could be used to make a product for commercial or industrial use."

One informant, a civil society actor in this case, went so far as to describe this *product* definition as the "standard definition", suggesting that it is, perhaps, emerging as a dominant policy imaginary.

> Civil Society Organization (#95): "Well we use sort of a standard definition where basically all materials, energy, chemicals and consumer products are built out of or based upon renewable biological resources, as opposed to non-renewable fossil fuels."

As a result of this focus on bio-based products, the broader policy vision tends to emphasize the *economic* aspects of the bio-economy, rather than the social, political, or sustainable aspects. As such, it reflects other bio-economy policy visions elsewhere, especially those developed by the OECD, EU, and USA [17–19]. As McCormick [23] notes, these visions emphasize the following:

- OECD [18]: development of "sustainable, eco-efficient and competitive products."
- CEC [17]: development of new products and integration of biological resources into the economy.
- USA [19]: use of (biological) science and innovation to create economic growth.

Such definitions mean that only certain policy strategies are deemed desirable or possible. For example, the emphasis on markets frames the use of certain measures (e.g., government incentives) to promote the bio-economy in certain ways (e.g., to create markets). Moreover, it frames the bio-economy normatively as driven by particular interests (e.g., consumers) at the expense of other concerns (e.g., ecological protection) [29].

Generally, how the future is defined and framed ends up shaping potential policy strategies and policy-making, especially when it comes to science, innovation, and market policies, and the various institutions and infrastructures on which these policies depend. As noted elsewhere in the literature, this, then, legitimates the shaping of policies and institutions to suit the future vision [13]. It is notable that this vision, while it might promote policy and institutional change, is underpinned by a policy agenda or strategy that emphasizes the integration or incorporation of bio-based products, energy, etc.,

into existing political economy, rather than challenging it with alternative political-economic paradigms (e.g., circular, degrowth, steady state, etc.) [36]. For examples see Table 3 below.

Table 3. The bio-economy as a product definition (part 2).

Informant	Definition
Trade Association (#97)	"So as far as the bio-economy goes, I mean, I think from our perspective we see it as an outlet or opportunity for-, to take demand for our product, essentially."
Provincial Ministry (#98)	"So bio-economy is—a what we call a bio-economy—an economic activity which is based on manufacturing of any biobased product. Using some of these renewable material—like agriculture, forestry based materials... So it's an economic act, we very advanced stage of product using renewable biomass materials to substitute fossil fuel based product and material."
Trade Association (#107)	"I think the bio-economy is leveraging the renewable resources that we're blessed with in Canada to deliver sustainable products to global markets."
Trade Association (#109)	"... about creating an environment where sustainable products and stable fuels can be more easily integrated into the economy of Canada. It's a comprehensive approach to the management of our resources in a way that promote the use of less carbon intensive fuels."

As the quotes in Tables 2 and 3 illustrate, the product definition is embedded within a *market-based* or *industrial-based* vision of the bio-economy as a new sector, new product market, new resource base, etc. It is not, in this framing, a threat to existing political economy or incumbent firms. This definition is the main way that industry actors frame the bio-economy; notably, it is also a common way that government actors frame it, although civil society actors do not use this definition, by and large. In terms of the Canadian context, this definition is likely a cause *and* effect of the fragmented policy framework in Canada (see below), which means that policy initiatives and instruments are often directed at narrow industrial sectors or product markets, meaning that it makes sense for both industry and government to define the bio-economy in similarly narrow terms. For example, a Federal Agency (#105) informant noted that "our roadmap is focused on industrial bioproducts stemming from agriculture", rather than from a range of biological resources.

The prevalence of the product-based definition in Canadian policy visions reflects a broader policy tendency to focus on a techno-fix to solve societal challenges, like energy security, climate change, rural development, etc. [12]. It corresponds to the policy agendas promoted by the OECD, which focus on advances in biotechnological sciences as *the* solution to societal problems [16]. An example from my research was an informant from Civil Society Association (#91) who defined the bio-economy as "renewable carbon and hydrogen chains to products that benefit society. We tend to exclude the food and the feed side". In considering this product-based representation of the bio-economy in relation to other policy jurisdictions, such definitions are more common in the policy visions of countries like the USA and Australia, rather than the more "bio-based" definitions used in places like Germany, Finland, and Sweden [21]. This is interesting for the simple reason that Canada's political economy is often characterized as a resource-based one, or "hewers of wood and drawers of water".

4.2. Competing Definitions of the Bio-Economy 2: Substitution

Closely aligned, even overlapping, with the product-based definition discussed above is the conception of the bio-economy as an economy defined by the *substitution* of biological products and services for fossil fuel-based ones. Although this definition could be characterized as a product-based vision of the bio-economy, there is one major difference setting it apart. The substitution definition is underpinned, as the name suggests, by replacement of existing products and services with wholly new products and services, representing a direct challenge, or even threat, to incumbent industry actors and the policy frameworks that support prevailing institutions and infrastructures. Examples of this definition are outlined in Table 4 below.

Table 4. The bio-economy as a substitution definition.

Informant	Definition
University (#90)	"... in a lot of people's minds it's substitution of bio-based material for fossil fuel-based ones"
Civil Society Association (#94)	"... substitution of either a biochemical or a fossil based chemical represents a tremendous gain in terms of footprint"
Provincial Ministry (#99)	"So it's an economic act, we very advanced stage of product using renewable biomass materials to substitute fossil fuel based product and material"
Federal Agency (#106)	"... we are going to be looking for things that can be fully replaced"
Provincial Ministry (#110)	"... substitute fossil based economy with a biobased economy"
Trade Association (#109)	"... we would like to replace those [petroleum based substances] with those that are not based on sequestered carbons"

As these quotes in Table 4 show, this definition is espoused, primarily, by government actors, especially in contrast to industry actors. The substitution definition illustrates how different policy visions can be contentious, controversial, and contested, meaning that they are less likely to become dominant or stable imaginaries. In the substitution case, while it may share similarities with the product-based definition—in that it also emphasizes the development of products and service—it implicitly and explicitly threatens existing industries (e.g., oil and gas). Consequently, it has not become a major policy vision in Canada and is unlikely to do so, as evident in the broader policy discourse. For example, "substitution" does not appear at all in one of the earliest Canadian bio-economy policy visions, called *Beyond Moose and Mountains: How We Can Build the World's Leading Bio-Based Economy* [37]. Furthermore, "fossil" only appears once in that policy vision when the document refers to the idea "that the bio-based economy can—and should—be to the 21st century what the fossil-based economy was to the 20th century" (p. 4). Here, this particular policy vision does not frame the bio-economy as threatening or even competing with incumbent industries, products, or markets, presenting it instead in more general terms.

Another reason that the substitution definition is contentious is that it is, necessarily, equivocal. On the one hand, the development of 'drop-in' bio-based products, services, and energy is the ideal because it means there is no need to replace existing institutions and infrastructures [24]. On the other hand, however, few people think that biomass can replace or supplant fossil fuels across the economy, mainly because the amount of biomass required would be beyond both human and the world's capacity to produce it [7,38]. As a University (#90) informant argued, "Biomass can't do everything in the economy. You know I don't believe that we are going to have enough of it". Another informant, Civil Society Organization (#92), explicitly argued that the bio-economy should, necessarily, represent an aspect of a future "hybrid" economy in which fossil fuels also play a significant role. In light of these questions about the potential of bio-based substitution, it is unlikely that the substitution definition can or will become a dominant or stable policy vision for the Canadian bio-economy. However, that does not mean that substitution is not important; as a Federal Agency (#105) informant noted, the bio-economy is "a way to sort of improve overall environmental sustainability" through the development of (bio-based) products with less damaging environmental impacts.

4.3. Competing Definitions of the Bio-Economy 3: Renewable versus Sustainable

Across bio-economy policy visions there is a tendency to conflate "renewable" with "sustainable", in the sense that bio-based materials, energy, products, etc., are envisioned as inherently sustainable because they are derived from renewable material. A number of scholars have highlighted this discursive framing in previous research [10,12,14,32]. As the previous sub-section illustrates, the bio-economy can then be framed as both sustainable—because it involves replacing fossil

fuels with biological matter—and politically feasible—because it involves like-for-like substitutions (e.g., ethanol for petroleum) rather than wholesale reconfiguration of societies. Examples of this definition are outlined in Table 5 below.

Table 5. The bio-economy as a renewable-sustainable definition.

Informant	Definition
Consultancy (#93)	"Renewable is one thing that's sort of inherent in the definition"
Consultancy (#100)	"... you're making products from renewable resources, whether it be trees or crops or whatever, then as long as those trees and crops are managed in a sustainable way, then obviously the bio-economy can be part of a sustainable economy"
Civil Society Association (#94)	"... the bio-economy is an industrial sector that depends on inputs from agriculture, forestry, it means inputs are renewable"

While Table 5 illustrates that this definition is not a dominant policy vision, it shows how the biophysical qualities of plants can end up being used to define the bio-economy as a "renewable" policy agenda to sit alongside renewable energy policy more generally. It is, however, an increasingly contested notion, as illustrated by the debates around the sustainability of first generation biofuels, especially ethanol, in the USA, Europe, and elsewhere [25]. For example, research by Gillon [39,40] on the USA and Palmer [41] in the EU examine contestations around claims about the contribution of biofuels, especially ethanol, to reducing GHG emissions. It is evident, moreover, in the Canadian context that this renewable definition is mainly an industry one, with limited evidence that it is used by government or civil society actors. Even industry actors frame "renewable" in a nuanced way, as demonstrated by a Consultancy's (#100) comment that: "then as long as those trees and crops are managed in a sustainable way, then obviously the bio-economy can be part of a sustainable economy".

As Pfau et al. [32] highlight, policy research on the bio-economy and sustainability has increasingly emphasized the problems associated with this vision of the bio-economy as inherently sustainable. It is evident that Canadian policy actors are similarly sceptical of the notion that the renewable characteristics of plants makes them, by definition, sustainable. As one informant noted, this renewable definition is problematic because it means the bio-economy, as a policy, is "not about sustainability anymore, and it's really about biotechnology; in fact, actually, many, but the problem is they imply it's sustainable because it's part of the bio-economy as a bioproduct" (University #96). Amongst other policy actors, there was a strong emphasis, in particular, on the need to integrate sustainability with the bio-economy, rather than see the former as inherent in the latter. Government informants, for example, stressed that the bio-economy meant "sustainable production of any biomass. So not only for biobased products" (Provincial Ministry #98) and the sustainable use of resources (Provincial Ministry #110). Such definitions were also evident amongst industry and civil society actors, as well. One industry informant, for example, said that "I don't think you have the bio-economy without environmental sustainability" (Trade Association #107), implying that they are distinct policy goals. A civil society informant was even clearer on this point, arguing that "when it's done right, when a bio-economy is done in a sustainable fashion, then it is sustainable... biomass is not necessarily sustainable" (Civil Society Organization #95). As these comments illustrate, the idea that the bio-economy is inherently sustainable is also framed as problematic.

4.4. Competing Definitions of the Bio-Economy 4: Societal Transitions

A final definition used by Canadian policy actors is the idea that the bio-economy represents a potential techno-economic transition pathway to a low-carbon future; as with the previous definitions, this definition is not unique to the Canadian context. Although many policy strategies are centred on product-based definitions of the bio-economy [23], according to de Besi and McCormick [22] (p. 10472) "An important aspect that features across the national and many of the regional [bio-economy]

strategies is the need for a transformation in the mind-sets of society, industries and governments". This societal transition definition is evident in Table 6 below.

Table 6. The bio-economy as a societal transition definition.

Informant	Definition
Provincial Ministry (#98)	"holistic approach"
Consultancy (#100)	"it's a shift away from the hydrocarbon economy to the carbohydrate economy"
Civil Society Organization (#95)	"for biomass to be sustainable, it has to be renewable within a human lifespan, it has to protect diversity, and it has to value the aesthetics and environmental services that biomass provides while it's living"
Civil Society Organization (#92)	"So you create something that's more of a hybrid system for transition"
University (#90)	"Well you know it's economy, right? So it's spanning not just an individual product or anything, it's all facets of our lives in terms of the way that our society functions and the role that biological resources can play in that"
University (#103)	"trying to shift our economy off the-, well I guess in our case, specifically the petro chemicals, and more onto biologicals that are renewable sustainable biologicals"
University (#96)	"idea of the carbon within our bio-economy is not fossil carbon, and it's based on biological systems"; "It was one that would move from a —it was like a fossil fuel-based economy to a bio-economy, where biological processes would, we'd use the power of photosynthetic plants and photosynthesis to bring energy and complex carbon molecules into our environment, and in the process not have to... be able to leave some of the fossil fuels in the ground"

As evidenced in Table 6, this definition is used predominantly by civil society stakeholders—it is not as evident amongst industry informants, if at all. It reflects a more critical understanding of the bio-economy, which Pfau et al. [32] highlight in their work. In their literature review of sustainability discussions of the bio-economy, Pfau et al. argue that one strand of this literature focuses on the negative impacts engendered by the bio-economy, which can include land use change and competition, unintended risks from things like invasive species, disconnection of crops from local ecosystems, and so on. The societal transition definition reflects these sorts of concerns in the Canadian context. Specifically, informants emphasized the need to address social, political, and economic issues as part of sustainability concerns; for example, changing social behaviours (e.g., driving less) as well as implementing techno-scientific solutions (e.g., advanced biofuels).

Although there are commonalities—such as the desire to make the economy more sustainable—this societal transition definition represents a competing vision of the bio-economy to the other definitions discussed above. As such, it represents an example of the conflict that arises in the development of future visions for our societies, as other analyses of the bio-economy have illustrated elsewhere [12,14,15]. A major issue, in the Canadian context at least, is the conflict that arises between dominant national imaginaries of Canadian society and those of the bio-economy. In particular, many informants, whether industry, government, or civil society actors, stressed the potential—and actual—conflict between incumbent petroleum industrial sectors (e.g., extraction, pipelines, retail, etc.) and the bio-economy. As a number of quotes in Table 6 show, the societal transitions definition is framed by the need to reduce the extraction and use of fossil fuels, as well as develop new institutions (e.g., life cycle analysis standards) and infrastructures (e.g., biomass transportation facilities), to support any societal transition, reflecting a clear difference from the other definitions that try to reduce these social costs through notions of substitution and 'drop-in'. As such, it also reflects a broader interest in concepts like the 'circular economy' and policies supporting renewable energy, recycling, etc. [36].

5. Fragmented Policy Frameworks in the Canadian Bio-Economy

As I have stressed already, it is important to analyse the policy visions surrounding the bio-economy (see above) in order to understand the co-constitution of these imaginaries with bio-economy policy frameworks. As noted in the theoretical discussion, future visions, narratives, or discourse (i.e., imaginaries) shape and are shaped by policy priorities, funding decisions, implementation processes, and so on [12–14,25]. That is, imaginaries and policy frameworks are co-constituted. An important point to remember, in this regard, is that these visions and frameworks have an effect even if the imagined future is not subsequently achieved since they still engender policy or institutional change [13]. So, even if the purported goals of the policy visions and frameworks are not realised, they still help to reconfigure policy strategies through institutional changes undertaken to support those strategies. From this perspective, the fact that Canada's bio-economy imaginary is still emergent and contested means that Canada's policy frameworks are likely to be uncoordinated. From my analysis of the interviews it is evident that Canada's bio-economy policy framework is highly fragmented; moreover, it could be argued that there are multiple policy frameworks. A number of informants argued that there is a need for a single policy vision to create a consistent policy framework in Canada. In this section I discuss the drivers of policy frameworks in Canada, the key actors involved, and the recent developments that might indicate a clearer and more consistent policy framework, as well as outlining a policy vision that might bring this about.

5.1. Configuring Policy Frameworks

In the Canadian context, bio-economy policy frameworks are fragmented as the result of the emergent and contested nature of policy imaginaries, as already discussed above. In contrast to the dominant approach that underpins the EU's bio-economy strategy [12–14], for example, Canadian policy visions and frameworks are fragmented by industry and the industrial sector. As one informant noted:

> "I don't necessarily think that a change in political party is going to make a big change, and I think partly because as a lobby group, the bio-economy players, the agents are just too fragmented. And there's not this over-arching vision about what it can be in terms of who all the players are" (Civil Society Organization #95).

A major reason for this fragmentation is that there is no 'overarching vision' to draw in government, industry, and civil society actors, who each have their own particular, and sometimes competing, priorities and objectives. In Canada, moreover, this situation is exacerbated by the fact that industry priorities and objectives often dominate policy-making [42]. For example, a Federal Agency (#105) informant noted that they are concerned mostly with "making sure that we're also aligned with where industry is thinking, we're going in this direction". As another informant from a Federal Agency (#106) pointed out, "they [government] go out to the stakeholders that are representatives of the target industries and say, 'what's missing?". It is evident that government policy-makers are less concerned with creating an overarching policy vision and framework than with addressing the particular and narrow concerns of different industrial sectors. This contrasts with the situation in the EU and other countries [21,22].

Fragmentation is a result of this dominance by industry priorities, broadly speaking, in that it leads to a lack of coordination as the different sectoral interests, priorities, and demands of different industry actors come into competition with one another. This is even the case when different industrial sectors have taken up the term 'bio-economy'; one informant, for example, suggested that "it [bio-economy] has been taken up by a number of companies and groups to actually broaden to any products from biological sources" (University #96). However, although industrial sectors have adopted the term 'bio-economy' in their policy advocacy, this does not mean they use it in the same way. For example, it has been used or adopted by agricultural, food, forestry, biotechnology, bioenergy, biofuels, and bio-product sectors (amongst others). Examples include:

- Forest Products Association of Canada: *Bio-Pathways Report* (2011) contains no real definition of 'bio-economy', but refers to "integrating current operations with new add-on processes that create bio-energy, biochemical and bio-materials that add value and jobs" [43] (p. 3).
- Canadian Renewable Fuels Association: *Evolution and Growth: From Biofuels to Bioeconomy* (2014) report contains, again, no real definition, but refers to "In addition to environmental benefits, the economic impact of a diverse bioeconomy sector affects the entire value chain, employs a wide array of sciences (life sciences, agronomy, ecology, food science and social sciences), and enables continual development in industrial technologies (biotechnology, nanotechnology and engineering)" [34].
- BIOTECanada: *Becoming a World Leading Bioeconomy by 2025* (2015) report refers to the fact that "The OECD has defined the world bioeconomy as comprising one-third of the total world economy. This includes renewable biomass, and the integration of biotechnology across sectors" [44] (p. 7).

Even when industrial sectors frame the bio-economy in 'product-based' terms, as discussed earlier, this discursive framing does not create an consistent or coherent policy vision and framework that *all* industry sectors can or will adopt. In fact, a product-based policy vision may militate against developing an over-arching policy framework precisely because it is focused on particular and sector-specific products and product strategies (Federal Agency #105). A product-based focus does not enable different stakeholders to develop complementary and cross-sectoral priorities or objectives; as one informant noted, "we're incentivizing innovation in a specific and narrow product line for a specific and narrow industry" (Civil Society Organization #95).

A final issue to consider is the extent to which Canadian bio-economy policy frameworks are configured by existing and incumbent industrial sectors, like agriculture, forestry, and energy. While this need not lead to fragmentation, there is a possibility that the orientation of bio-economy policy frameworks towards incumbent and often natural resource sectors (e.g., agriculture, forestry) limits the relevance of the bio-economy for other sectors. One informant claimed:

> "It seems like each of them sort of had people that were sort of, they were trying to figure out how we're going to use these, the old mills, and of course the bio-economy was a way of doing it" (Federal Ministry #104).

Whether or not this emphasis has configured bio-economy policy visions and frameworks in ways that limit its attractiveness to other sectors is a question worth asking. In particular, the bio-economy seems to have been seized on as a potential strategy for reinvigorating ailing sectors. For example, one informant argued that "around the latter part of the 1990s the policy platform started to shift and industrial crops were being sought to make things like biofuels to benefit farmers" (Consultancy #93).

5.2. Fragmented Policy Frameworks

The fragmentation of bio-economy policy frameworks in Canada can be seen as a consequence of the broader constitutional structure. In particular, natural resource management falls within provincial jurisdictions, meaning that the national state might only be able to provide limited direction or oversight in promoting an over-arching bio-economy policy vision and framework. As a result, different government agencies and ministries—at the federal and provincial scales—have developed different policy frameworks, if they have one at all. It is worth considering, then, the differences between federal and provincial policy frameworks in order to understand their fragmentation.

At the federal level, a number of informants explicitly stated that Canada does not have a bio-economy strategy as such, although policy-makers have been working on one—a point I return to below. For example:

- Well, I mean we don't really have a bio-economy strategy per se, right... You know you can talk about some bio-economy strategy and stuff, but, you know, then you run into details" (University #90).

- "Canada does not have a national bio-economy strategy... Yeah we do need to get something like that in place here. And we don't really have it on a provincial basis either" (Civil Society Organization #92).
- "Canadian policy on bio-economy, we really don't have one for agriculture" (Civil Society Association #94).
- "Well, we don't have federally anything that is sort of called a bio-economy policy, at least certainly not one that I'm aware of" (Consultancy #100).
- "Well, certainly you're probably even more familiar than I am of some significant nations have put in place bio-economy policies, Canada has not. That doesn't mean that there aren't really good things in place from a policy perspective that supports bio-economy" (Trade Association #107).
- "We don't have, even in Canada we don't have a federal framework to support bio-economy" (Provincial Ministry #110).

This is not to suggest that there is little support for industry from the federal government; the opposite is the case, as an examination of policy initiatives demonstrates. A number of informants provided detailed accounts of various policies, initiatives, and schemes that supported an array of industries. For example, *EcoENERGY for Biofuels and Renewable Power* (est. 2008); *Sustainable Technology Development Canada Fund* and *NextGen Biofuels Fund* (est. 2007); *Renewable Fuel Standard* (est. 2006); and many more [45]. Rather, it is that the bio-economy is not envisaged as a coherent whole, as one informant explained:

> "So, again, the bio-economy for us is the piece that weaves all of our other asks together. The individual asks, we actually get a lot of support for... But an overarching framework just sounds like a lot of work, right?" (Trade Association #109).

Another illustration of the fragmentation of Canada's bio-economy strategy is the role played by provincial governments in promoting it. One informant even suggested that "we see this leadership coming-, leadership if you will, coming from the provinces" (Trade Association #97). While provincial policy-makers play a more critical role in supporting and promoting the bio-economy, this merely entrenches the fragmentation of bio-economy policy visions and frameworks as each province develops its own approach based on their different starting positions and plans for the future. For example, Birch and Calvert [24] provide details of the various mechanisms in place to support bioenergy and biofuels in Ontario, illustrating the role played by provincial governments in supporting new sectors. In this sense, it is possible to argue that provinces like Ontario have informal and largely implicit bio-economy strategies in place, as one informant claimed. This informant argued that Ontario's policy instruments included a "combination of investment attraction and research that evolved into a provincial policy... part that we're missing in the provincial policy is the greenhouse gas component" (Civil Society Association #94). A more common outcome of this jurisdictional alignment, however, was the creation of ad hoc policy instruments where "It's almost kind of like by accident you can take something from a province and something from a federal and build something that will help the bio-economy" (Consultancy #100). As such, the onus has been on integrating distributed policy instruments in the pursuit and support of different and distinct industrial sectors, rather than creating an over-arching strategy. Whether or not a national policy vision is actually possible in this context is another question worth asking.

In relation to Canadian it is interesting to note that industry is far more involved in developing a common—if not over-arching—policy framework than government, especially in comparison with the EU or other countries [12–14]. A number of informants emphasized this point during my research interviews. One informant, for example, claimed that:

> " . . . there is a sense out there that it needs to be done [to support biofuels], but no, I think honestly, I think the industry, the private sector, is a little more wound up about this right now than the government guys" (University #103).

It is important to note that these interviews were undertaken during the previous Conservative Party administration, which ended in October 2015. The political orientation of the Conservative government meant that it preferred market-based strategies driven by industry, rather than policy strategies driven by government [42]. As such, there was political uncertainty about the development of bio-economy strategies within government itself, as one industry informant noted: "And the difficulty with that [politics] is it becomes very unpredictable from a policy standpoint. So honestly a lot of our positioning on the bio-economy is defensive" (Trade Association #99). Whether or not a change in government will make a major difference is debatable, however, as another informant noted:

> "I don't necessarily think that a change in political party is going to make a big change, and I think partly because as a lobby group, the bio-economy players, the agents are just too fragmented. And there's not this over-arching vision about what it can be in terms of who all the players are" (Civil Society Organization #95).

It is, according to many informants, critical for various stakeholders from government, industry, and civil society to collaborate with one another in order to develop a coordinated federal bio-economy strategy. Otherwise, fragmentation is likely to continue. For example, the FPAC [43], CRFA [34], and BIOTECanada [44] reports I cite above all stress the need for such a coordinated policy vision and framework.

5.3. Recent Changes and Ways Forward

Over the last few years, there has been some movement towards coordinating policy approaches towards the bio-economy at the federal level in Canada. In particular, a number of informants referred to the creation of a Bioeconomy Interdepartmental Working Group (BIWG) in the federal government; created in 2013, it is supposed to bring together people from around 15 different federal ministries and agencies. One informant stated that the "overall goal of the group [BIWG] is to develop a Government of Canada strategy for the bio-economy" (Federal Agency #105). As yet, the BIWG has not produced any public publications or recommendations, and seems to be largely focused on fostering collaboration across federal ministries and agencies. Some federal ministries and agencies have started to create other working groups as well; for example, Agriculture and Agri-Food Canada (AAFC)—itself a member of the BIWG—has established a Federal-Provincial-Territorial Bioproducts Working Group and Industrial Bioproducts Value Chain Round Table.

From a policy perspective going forward, Canadian policy-makers need to develop a coherent vision of the bio-economy in order to avoid the continuing fragmentation of policy frameworks; a coherent policy vision will enable the development of a coherent policy framework for the bio-economy across federal and provincial jurisdictions. Although I have identified series of competing and contrasting policy visions of the bio-economy in Canada, it is still possible to construct a common policy vision from these various definitions. This necessarily involves political and normative choices, even though it draws on the empirical findings I have presented here. In drawing on the various definitions, for example, I would suggest that a broad and encompassing vision is necessary to enrol a range of stakeholders. My suggestion would be as follows:

> The bio-economy is a concept that refers to the sustainable use of biological, renewable materials in the development of bio-based products, services and energy that substitute for existing fossil fuel-based products, services, and energy, as part of a broader societal transition to a low-carbon future.

As a definition, it provides a vision of the process underpinning the bio-economy (e.g., "sustainable use of biological, renewable material"), what its outcomes are (e.g., "the development of bio-based products, services and energy"), how these outcomes will impact us now (e.g., "that substitute for existing fossil fuel-based products, services and energy"), and why this actually matters (e.g., "part of a broader societal transition to a low-carbon future"). It could, therefore,

provide a clear, coherent, and encompassing vision of the bio-economy that a range of policy actors could adopt in their future decision-making, and thereby reduce the current fragmentation of bio-economy policy frameworks. Moreover, it avoids the suggestion that the bio-economy is either the solution to everything, or the only transition pathway that we can adopt to solve the environmental (and societal) problems we face in the 21st century.

It is important to acknowledge here that any policy vision necessitates some form of prioritization; as such, trade-offs between different goals (e.g., sustainability versus economic growth) require that prevailing assumptions are not built into future policy visions and frameworks (e.g., economic growth trumps sustainability). It is also important to acknowledge that it might make more sense, in the Canadian context at least, to develop bio-economy policy strategies—and their constitutive visions and frameworks—at the provincial scale, rather than national scale. However, that being said, fragmentation is still likely without a policy vision that crosses provincial jurisdictions, since one province might develop a vision that contrasts sharply with another province, thereby reducing the likelihood that federal initiatives are applicable to both. Therefore, like Europe, it might make for federal policy-makers and stakeholders to develop a unifying vision.

6. Conclusions

Over the last few years, many countries, regions, and industries have started to promote and support the bio-economy as an important pathway for societal transition towards a low-carbon and environmentally-sustainable future. The bio-economy has the potential to transform an array of industrial sectors, promising a win-win scenario in which economic growth and environmental stewardship can go hand-in-hand. While these policy visions of the bio-economy represent an *imagined* future—in that they do not necessarily reflect current techno-scientific or political-economic trajectories—they are still powerful drivers of societal change. As Hilgartner [16] and others suggest, policy visions are powerful because they enrol a range of stakeholders in their achievement, they attract resources, they engender popular support, and they side-line possible alternatives. Whether the bio-economy actually makes an impact as imagined in resolving societal challenges like climate change, economic decline, rural development, or energy security, could end up as a side issue; it will still have changed policy frameworks and social institutions in important ways.

In this paper I sought to explore the bio-economy as a policy strategy co-constituted by policy visions and policy frameworks. In so doing, I built on previous research by Birch et al. [12,13] and Levidow et al. [14,15], and extended this research by analysing the bio-economy in a Canadian context. While others have written about different national bio-economy strategies (e.g., [7,21,22]), this paper represents the first attempt to dissect the particularities of the Canadian bio-economy. My analysis illustrates that Canadian policy visions are split between at least four definitions of the bio-economy: product-based, substitution, sustainable-renewable, and societal transition. Moreover, my analysis shows how these different and competing visions of the bio-economy are reflected in the fragmented bio-economy policy frameworks in Canada. As yet, no coherent or coordinated policy framework exists in Canada, but that does not mean one cannot be developed. I provide a possible definition of the bio-economy that incorporates elements of the four definitions I discuss, in the hopes that this could provide a clear and over-arching vision for the future of the bio-economy in Canada.

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